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EVOLUTION

A JOURNAL OF NATURE

NATURE'S UPSTART: HOMO SAPIENS — William K. Gregory

THE CONFUSION OF TONGUES — Oscar Riddle

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Where Nature Exposes the Secrets of Her Billion Year Past

(See page seven)

Courtesy United States Department of the Interior

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EVOLUTION

A Journal of Nature

*For Popular Education in Natural Science
To Develop the Open Mind*

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CARROLL LANE FENTON
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THREE OF EVOLUTION's most ardent supporters whose names appeared on the editorial masthead, have died since the last issue appeared: Dr. Martin Dewey, former President of the American Dental Association, Maynard Shipley, President of the Science League of America, and Dr. Elihu Thomson, Research Physicist of the General Electric Company. All three were valiant champions of popular enlightenment. Let their memories encourage us to carry through to ultimate triumphant success the cause they served so well.

WE ARE PROUD TO ANNOUNCE that Dr. Oscar Riddle of the Carnegie Institution of Washington, Station for Experimental Evolution, joins the Scientific Advisory Board of EVOLUTION. We think our readers will agree that "The Confusion of Tongues" is a real classic in this struggle for Science Freedom.

Miss Lucy Orenstein, a biology teacher in Evander Childs High School, New York City, becomes one of our contributing editors. She has an intense personal interest in evolution, and knows how to convey this interest to beginning students. Her first contribution to our columns is this month's "Question Box."

WHAT'S IN A NAME?

SOME WELL MEANING FRIENDS have advised that it would be easier to make a commercial success of this journal if we changed EVOLUTION to some "less offensive" name. If we were ever to make this change, the logical time was with this first issue after suspension.

It is true that some who now refuse might subscribe for EVOLUTION under some other name, and advertisers might be induced to pay for space. But if we yielded to this commercial pressure to change the name, the pressure would become even greater to leave out the subject matter too, to become merely another journal dealing with nature's "beauties" and "marvels" and sidestepping all such "controversial" subjects as evolution and its implications. The problem would not be solved short of surrender.

No, there is already an ample parade of pussyfooting in this land, without our joining the procession. We believe that there is real need for a popular journal that refuses this compromise with error, that will not equivocate by withholding facts or misusing words to hide their real meaning. It is not our purpose to discover some camouflage that will enable us to exist while leaving superstition to flourish, but to eliminate it from the human mind by helping to spread the light of science.

We have full sympathy with the lone biology teacher, who has to manage the subject under the nose of some ignorant politician-principal and harrassed by a fundamentalist school board. But it would be an ill service to this teacher if we acted as though evolution is something

sinister, something to be ashamed of, that must not be mentioned. In the long run we shall serve even this teacher best by coming out boldly with the fact of evolution. If we stand up, others also will find courage to make the stand. So we'll hold the banner high.

In a way, the very suggestion to change the name of EVOLUTION proves the need for this journal. Some professors, sheltered in cloistered college halls, may think that "every intelligent person accepts evolution" and popular education isn't needed, but they are wrong. We hope to carry on until the humblest teacher in the most backward school district has complete freedom to convey to inquiring youth the full meaning of all that science learns regarding Man's place in Nature.

In this endeavor we invite not merely the sufferance but the active co-operation of every reader. —L.E.K.

A PERSONAL WORD

AS I'VE MET A MAJORITY of our 7,700 EVOLUTION subscribers face to face I'll address you personally.

First I wish to express appreciation for the courtesy with which you received me, the confidence you showed in me, a stranger who came to your door, and the patience with which you have awaited the appearance of EVOLUTION. I hope you will deem it worth while.

During the five years since the last issue of EVOLUTION appeared I have canvassed for it in practically every city of over 100,000 in the United States and a great many smaller communities, all the larger colleges and universities, and hundreds of high schools in 45 States and in Canada. In securing over four thousand subscribers personally I probably talked about EVOLUTION with over 20,000 persons, traveled 30,000 miles by bus and train, walked at least 12,000 miles and rode an equal distance by street buses and cars. And I am more convinced that there is a need and a real field for EVOLUTION than I was before I started.

Although I did not succeed in finding an "angel" for this enterprise, I now feel that through this field-work a sufficient foundation has been laid to justify resuming publication. Nearly a thousand new subscribers have promised to remit after receipt of the first number; several hundred have told me that they would try to secure additional subscribers; others pledged donations for the Library and Sustaining Fund; many teachers will offer EVOLUTION for sale to students; over a hundred editors have promised reviews of this issue in their journals; a large number of eminent research scientists, writers and teachers have promised material for articles; literally thousands now understand what EVOLUTION hopes to do, wish it well, and will further its work.—L.E.K.

Nature's Upstart: Homo Sapiens

By WILLIAM KING GREGORY

Curator of Department of Comparative Anatomy, American Museum of Natural History
Professor of Vertebrate Paleontology, Columbia University

IF *Homo sapiens* had not had an aggravated superiority complex he would never have applied the adjective *sapiens* to himself in the face of overwhelming evidence that he deserves rather to be called *Homo inflatus*. The daily course of the sun as well as the rising and setting of the stars suggested that man's home the earth was the center around which the rest of the universe turned. Hence it was but a short step to the idea that man himself was correspondingly important in the cosmic plan.

In the mythology of the Greeks the gods were so intensely interested in the affairs of men that they took sides with the opposing heroes and heaven was more disturbed by the disputes following the stealing of one woman than it would normally have been by the sacking of ten cities. Not even Zeus himself disdained the charms of the daughters of men and from such crossings of gods and men sprang various lines of half divine kings. As to the ancient Teutonic deities, one hesitates to dwell upon their all too human frailties; but to people beyond the pale of the magic swastika it is apparent that though some of these good old German gods and goddesses were not exactly all that they should be, they were regarded as ideal companions for the spirits of warrior heroes. The unregenerate *Homo sapiens*, especially in the allegedly civilized countries, has usually imagined his race to be the hero of the drama of creation.

Deflation of Homo Sapiens

For his soul's good, however, I deem it my duty to puncture the bubble of *Homo sapiens*. For it is only after we are all properly deflated and made to realize what miserable sinners we are that we can find the way of redemption from the follies of anthropocentrism.

At this period in the history of science it is assuredly unnecessary to review the evidence tending to show that the earth, far from being in any scientific sense the center of the universe, is not even the center of the solar system.

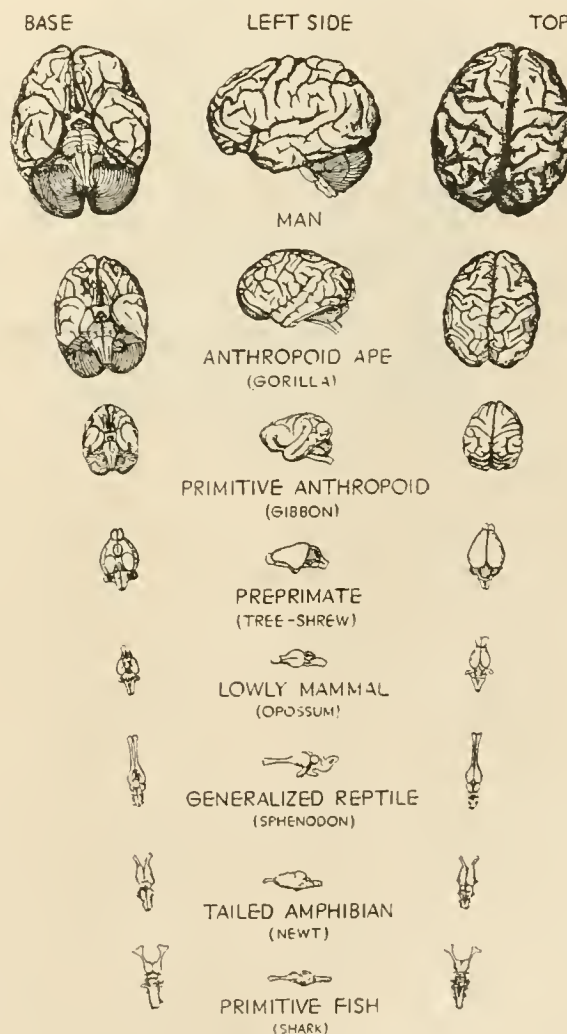
From Science 83:41 & 69
Jan. 17 & 24, 1936

But in spite of the collapse of the geocentric system of astronomy, the anthropocentric view of cosmology has managed to survive in many quarters. Yet in addressing a scientific audience it is not necessary even to summarize the evidence that man was not created specially and apart from other living things but that he like them arose by evolution from earlier and lower forms of animal life.

If this be granted as a general proposition, we are in a position to outline a number of conclusions with regard to the evolution of man, which, if accepted, tend on the one hand to clarify his relations to the rest of nature and on the other hand to explain, at least in some measure, his general pattern of behavior.

Homo sapiens, like other animals, is a sort of living solar engine, which, unlike the plants, is unable to appropriate for himself the life-giving energy of the sun but must take that energy, in the form of food, from plants or other animals or both. Hence, by the primary law of his nature, he tends to take what he wants when he wants it and, as we shall see later, it is owing only to the beneficial restraints of various social systems that man learns to resist even in part these deep-seated urges to pluck and eat or to kill and eat. Since neolithic times man has by co-operative effort deliberately multiplied his food supplies by the raising of food plants and by the breeding of ruminant animals. Before such a cooperative stage was attained, the human animal had to depend more directly upon his individual equipment as a vertebrate, as a mammal and as an offshoot of the anthropoid division of the order of Primates. Even now the most advanced normal examples of *Homo sapiens* could hardly carry on the daily business of life without benefit of a long series of "basic patents" which man has inherited from earlier vertebrates, to some of which we must refer even if very briefly.

The earliest chordates were already adjusted to the force of gravitation by a dorso-



RISE OF THE HUMAN BRAIN

From fish to man the forebrain increases in size and complexity. In lower forms it functions chiefly with the smelling nerves. In mammals the upper part of the forebrain, differentiated as the neopallium or new brain, assumes control and, greatly infolded, largely conceals the older parts of the brain.

The forms figured here all live today. Although not ancestral their brains represent a progressive series.

ventral asymmetry, the neural tube being above the notochord and gut. Like modern fish they were also adjusted for forward progression through the water by means of a bilaterally symmetrical arrangement of the muscle-segments on either side of the midline.

Among other fundamental adjustments of the basal vertebrate type which are retained by man is the backbone itself; this is a jointed axis in which the individual vertebrae comprise checker-like centra formed around the notochord and arches spanning the nerve chord. The functions of the column were complex but may be summarized as follows: first, each segment served as a fulcrum or pivot upon which those in front of and behind it turned; secondly, the arches and processes served as levers for turning the body in the directions of the tendons of the axial muscles. The vertebrae also served as pivots for the ribs, to which were attached the muscle segments of the flanks and back.

Progression through the water in the earlier vertebrate forms was and is today largely by means of lateral undulations of the body as a whole, the fins being at first merely keel-like outgrowths of the body wall. The legs of quadrupeds were merely fleshy outgrowths of the lateral muscles, supported internally by bones secreted in the spaces between the muscle masses. There is strong evidence for the view that the hands and feet of the four-footed or tetrapod vertebrates were formed by modification of the stout pectoral and pelvic paddles of the lobe-finned fishes. In any case, by the time of the Coal Measures the five-rayed appendage had already appeared. Thus the foundations of the decimal system may be said to have been provided by the first amphibians of the Carboniferous Age, some 250,000,000 years ago.

The limbs are bent levers and act like springs and throwing sticks. At first the limbs were short and sharply crooked outward at the elbows and knees, but by the time of the more advanced mammal-like reptiles the body was raised well off the ground and the trackway began to narrow. Very early in the Tertiary period, when mammals became dominant land forms, the ancestors of the Primates are shown by fossils to have been tree-climbing forms with grasping hands and feet. This was the beginning of our prehensile hands, but did we also at one time have prehensile feet? Space is lacking here to discuss this question but it may be said that the convergence of evidence from paleontology, comparative anatomy and embryology affords strong support for the view that the peculiar foot of man has been derived from a primitive anthropoid type with a divergent big toe. This change took place chiefly by the drawing of the big toe towards the others and by the marked lessening in length of the second to the fifth digits inclusive. In brief, there is very convincing evidence that the early Primates ancestral to man were forestliving arboreal animals, and that the immediate ancestors of man, probably through the disappearance of the forest in certain areas in central Asia, had to accustom themselves at first to life on the ground in a more open country. It is difficult to escape the conclusion that man owes the general ground-plan of his foot to his long-extinct anthropoid ancestors but that he owes to his more immediate prehuman ancestors those special modifications of his feet which fit them for his upright posture.

With the assumption of the upright gait new stresses were put upon the backbone, which responded by greatly widening the sacral vertebrae, by forming the so-called lumbar curve and by remodelling the hip bone so as to in-

crease the width of the area for the gluteal and iliacus muscles and at the same time to bring the center of gravity of the thorax more directly above the transverse line connecting the sockets of the opposite femora.

The resultant freeing of the forelimbs from strictly locomotive duties has often been noted, but what is not generally realized is the fact that this great advance in their use as hands is already in full swing among the anthropoid apes, in which it is likewise associated with the ability to examine things closely with both eyes at once.

If space permitted, we might profitably review these matters in much greater detail and we might also follow the evolution of the jaws from their origin as a pair of enlarged gill-bars in the earliest true fishes to their subsequent modification through the varied use of the sheathing bones surrounding the primary or inner jaws. And from this point, which is fully represented in the air-breathing, lobe-finned fishes, in the ancestral amphibians and early reptiles, we could trace the profound transformation of the jaws and teeth during the period of the evolution of the mammal-like reptiles and the emergence of the lower mammals, and finally of man. But as I have described these things in many previous communications to scientific societies, I merely refer to them here in passing, as I desire to touch upon some of the social results of all these changes during the long road of ascent from fish to man.

The Penalty of Being Homo Sapiens

When the ancestors of man left the forests and were changed into primitive men their brains rapidly grew much larger than those of their more backward relatives, the known anthropoid apes. But increased brain power was by no means an unmixed blessing, for though on the one hand it was indeed necessary for permanent advance in the mental world, its possession subjected the owners to a multitude of evils undreamed of in the relatively peaceful and unintelligent world of the anthropoid apes.

We do not have to commit ourselves in advance to any particular theory of the relations between mind and matter, but since we must admit from the evidence assembled by comparative neurologists that there has been a progressive evolution of the nervous system, we must further assume that psychic side of nervous activity has likewise become more complex. The evidence at hand indicates that in the relatively simple nervous system of the shark the responses to sensory stimuli occur with a minimum of complexities and delays, whereas in the highly complex brain of the higher mammals the neopallium or new brain forms a most elaborate detour which is imposed on top of and between the more direct pathways of the primitive vertebrate brain. Such is the speed of nerve currents, however, that the slight delay in response is far overshadowed in importance by the superior initial advantages of the new method. For no matter what may be the physical basis of memory, it is at least certain that mammals have a peculiarly good memory for whatever classes of events happen to be of interest to them.

Thus each new stimulus, giving rise to a specific desire for action of some sort, is confronted with the memories of what happened the last time when a similar impulse was not restrained. The animal soon remembers the best way to respond so as to attain his immediate objective. Thus we have the basis of learning, that is, of progressively improved adjustments to familiar situations.

(Continued on Page 6)

The Confusion Of Tongues

By OSCAR RIDDLE

Carnegie Institution of Washington, Station for Experimental Evolution, Cold Spring Harbor.

DURING the past fifteen years several states have passed laws which prohibit the teaching of evolution in their public schools. This prohibition, and a strong sentiment of similar nature elsewhere, implies several most serious things. We know the importance of the textbook, and we may first note that this sentiment has written itself into some text-books widely used in both high school and college. These books put not emphasis but a wet blanket on one or all aspects of the evolution principle; and they often succeed in leaving only a pale ghost of our science in the student's hands. I submit as evidence some excerpts from an elementary text-book published in 1934 and already introduced into more than 131 normal schools and colleges in at least thirty-seven of our states and territories. A chapter of this book is entitled: "The process of evolution cannot yet be satisfactorily explained." The final section of this chapter is dedicated solely to the proposition that what it calls "the doctrine of evolution is quite compatible with a religious faith." Of course to the untrained pupil this can only mean that it is quite compatible with whatever view of religion, or of the supernatural, he or she happens to have at the moment. I quote from four paragraphs the following illuminating lines:

"The reader should remember that even Darwin himself did not believe acceptance of the evolutionary idea to be incompatible with a religious faith . . . Why should the full blown rose, the birds in the trees, the beasts in the field and the stately oaks standing in the forest not be considered as much a part of God's world as the subjects of which the Bible treats?" There follow four lines from the Psalmist, and then this: "If this conception of the universe were kept in mind it would obviate much strife and confusion. The scientist can make no distinction between the natural and the so-called supernatural. What man can study, experience, and learn about through his senses is the natural; the supernatural is that part of the universe which he has not yet been able to understand (*sic*) or for which his powers of comprehension are too limited. There is no difference between the two. The difference comes only in man himself. . . . So, then, since evolution neither denies the existence of God nor disclaims His directive influence over natural processes, it cannot be said," etc., etc. Then, "Finally, it must be remembered that the theory of evolution does not attempt to say when, why, or by whom life was first produced upon the earth. The honest scientist when pressed for an answer will say that he does not know."

Why any text-book whose purpose is to outline and guide in the study of life-science should contain a single word on the subject discussed at such length in this book is beyond comprehension. Your zoologist who loves, teaches

and builds his science very well knows that his task is to facilitate an advantageous encounter between the student and the useful and vitally significant phenomena and principles of biology. As a true scientist he will not rob his teaching of that special and incomparable discipline which only the sciences can give—his student will have to wrestle with the facts and principles he finds. If, and when, astonishment at the inclusion of such material in a text-book is sufficiently overcome, the biologist who knows that his science to-day is not where Darwin left it will swear that he had not believed it possible—outside of theological discussions—to find words for a few extraneous paragraphs that would so defraud our science.

If one could subtract the emasculated biology taught from such texts in 1935 from the total for 1935, how would the amount of zoology taught now compare with that in 1905? Some of the zoological text-books of thirty years ago may have been dry; but they were not rotten.

Our effort is to learn why biological science has not obtained and maintained its proper place in our schools, and why great biologic truth is so little possessed by our people. We have yet to search the motivation of those several instances of state laws which prohibit the teaching of evolu-

tion. It was traditional religion that thus invoked the heavy hand of legislation. Elsewhere, without invoking the law but with its extended and varied influence, traditional religion is now effecting a wide-spread repression of the teaching of this central principle of biology in our public schools. It sometimes forces the resignation of able zoologists even from college positions; and in high schools and late primary grades there are probably to-day few places where straightforward teaching of the unmitigated evolution principle can be done except at the peril of the teacher. An eviscerated straw-man is set up in place of the reality for the younger students of denominational and parochial schools everywhere. Many millions of our present and future citizens are robbed of a biological outlook, or they get one that is warped and unrecognizable, through direct responsibility of the church.

Biologists in nearly all countries, and particularly in our own, have tried a compromise with religious creeds. That compromise has failed. Most youth of 1935, like those of 1859, leave our schools without having opportunity to learn that the worthy facts concerning man's origin and destiny come not from religious traditions but from biological investigations made within the time of men now living. That compromise now robs most modern youth of opportunity to learn what is known concerning his or her place in nature. In what is said here I am not concerned with the question whether religion is important; nor whether one or another of the creeds of the earth has



Dr. OSCAR RIDDLE

or has not sufficiently "adjusted" its teachings to modern knowledge; nor whether one or another of them is good, bad or quite indifferent. But whatever the answer to those questions the present restrictive influence of organized religion on the teaching of the best of biology is intolerable. For moribund traditional beliefs to continue to exercise such influence over the educational program of a country is a confession and declaration either of the apathy, the cowardice, the impotence or the intellectual bankruptcy of enlightened leadership in that country.

It is here that we meet "the confusion of tongues." A hundred years of a germ of truth, or seventy-six years since its bloom in publication, has catalyzed a very wide-ranging body of facts relating worthily to the nature, origin and destiny of man. However, by many this prime accomplishment of our science is either rejected outright, or its essentials are first thoroughly eviscerated and the husks then accorded an obscure corner in the attics of tradition. The tongues of the traditionalists are heard not merely from pulpits, but they echo also within our schools—the only possible home of science—and there they now curb or tie the tongues of biologic truth.

This confusion is partly sustained by the words of great authorities in one or another branch of learning. Today, as at Oxford in 1860, a professor can easily be had to support a bishop against a really good and far-reaching biological advance, where this impinges on traditional beliefs. The public can not fix relative values to the words of different scientific men. But the biologist knows that when physicists and astronomers speak about life, they speak as laymen—and frequently their words are unconsciously filled with tradition, which they also acquired as laymen. In addition to these volunteer voices from quite outside life-science, we are all aware that some high authorities in biological science persistently ignore the greater biologic accomplishment, and on some points they too still speak with tongues of a day that is gone. We

may as well have it out with them.

In conclusion, no one need espouse intellectual sterility because many and important mysteries still attach to the living world. The task of serious biological analysis—the thrust of observation and experiment against assumption and tradition—was begun only yesterday; and, very unfortunately and quite inexcusably, it is not until an unseen to-morrow that even 1 per cent of mankind will become conscious of as much as 10 per cent. of the quite important mysteries which a sharp attack has already swept away. The issue to-day is on the question whether our educational facilities and practice will permit eager youth to examine the results of man's scientific efforts to learn man's own nature and man's place in nature; whether ignorance of many fundamental and now satisfactorily appraised biological phenomena shall continue to foster divergent and irreconcilable thought among great biological human populations which must live together; whether the case and the course of civilization is to be guided by knowledge or by the dead hands of the past; whether the biological investigator of either yesterday or today may be permitted to give his best results to the world or whether he is to be more and more insulated by his own progress; whether, indeed, present man-in-the-mass has evolved sufficiently to prefer light to twilight, truth to tradition. Certainly until this issue has been definitely decided every zoologist will feel sure that mankind is worthy of much more than his very best efforts; he, along with all other enlightened men, must find, recognize and overcome those forces which now obstruct the release of his best prizes to present generations of man.

Excerpt, vice presidential address, Section Zoological Sciences, A.A.A.S., St. Louis, Jan. 1, '36. Printed in *Science*, 83: 41 & 69, Jan. 17 & 24, 1936.

CORRECTION

The credit lines on pages 3 and 5 got mixed. Dr. Gregory's article is from *The Teaching Biologist*, Dr. Riddle's from *Science*. My own fault. L.E.K.

NATURE'S UPSTART: *HOMO SAPIENS*

Continued from Page 4

Up to the time that the ancestors of man began to become human, the newer type of response may have been almost as uniformly beneficial and successful as it seems to be in other mammals. But at this point the devil appears in the story to wreak havoc on the happiness of simple humans. This devil is nothing more nor less than the habit of unintelligent and uncritical yielding to suggestion, that is, to arbitrary association of ideas. The "conditional response" of Pavlov on a lower plane foreshadows the vast brood of taboos, phobias, blessings and curses and all the practices of magic and superstition on the plane of social relations. For example, among many primitive peoples, sickness is not the result of some purely physical or physiological disturbance but is sent by the gods as a penalty for the violation of taboos, perhaps by another member of the family. The way to cure the sickness, therefore, is to pay a witch-doctor to find the culprit whose sin has brought the sickness and punish the culprit.

The invention of speech, in which a given sound or a series of sounds is arbitrarily associated with a certain idea, led to verbalized thinking and enormously facilitated the establishment of habits of reaction based on fictitious taboos and rewards. As a result of this situation the progress of humanity in discovering the causes of disease and curing it was delayed for ages and is still delayed among the less intelligent of all lands.

Another factor which has contributed greatly to the bedevilment of *Homo sapiens* is his almost incurable pride and egocentrism joined to a pathetic gullibility. Egocentrism and selfishness are natural in the descendant of a long line of vertebrates which are designed by nature to pluck or kill and eat without any regard to property rights. The gullibility follows from the easily imposed habit of acting in masses under the suggestion of leaders. Also the tendency to believe the oft-repeated printed word.

In short it seems that a large part of the agony of mankind could have been spared if man had been at the same time less egocentric and less credulous.

The Emancipation of *Homo Sapiens*

In spite of man's tragic subservience to mass manipulation, one must admit that during historic times there has been definite improvement in some individuals and in some communities and even in a few states. The main hope for *Homo sapiens* seems to lie in the principle enunciated by Lincoln, namely, "that you can fool some of the people all the time and all of the people some of the time but you can not fool all the people all the time". It is the tough-minded residue, as well as those who can learn by experience, who slowly sift the wheat from the chaff, hold fast to that which is good and press forward steadily to a more rational world; there justice and gentleness shall ameliorate the hard fact that *Homo sapiens* is the descendant of a long line of aggressive vertebrates.

An Evolutionary Time Scale

By A. M. WOODBURY

Professor of Biology, University of Utah

THE ordinary visitor to Zion and Bryce Canyons of southern Utah and to the Grand Canyon of Arizona little realizes the wealth of scientific information to be found in the geological history of the region and its significance in the interpretation of evolution. The time scale in evolution depends for its interpretation largely upon the relative positions of the different rock layers of the earth. Here, the sedimentary rock layers, spread out in horizontal fashion one above the other, produce a total depth of about three miles. These layers have been relatively but little disturbed so that they clearly show their relationships to one another.

The edges of these rock layers are so exposed to view that they can be traced readily. The bottom-most mile of these rock layers is exposed in the Grand Canyon (Evolution Vol. 3, No. 4, p. 10, May, 1932). The second mile of such layers may be found exposed between the brink of the Grand Canyon and the top of Zion Canyon. The third mile extends up the face of the higher plateaus to the top of Bryce Canyon (See Chart).

The extremely old rocks exposed in the bottom of the Grand Canyon are the foundation upon which the horizontal stratified sedimentary layers rest. It is obvious that the lower rocks must have been in position before the succeeding layers could have been deposited on top. These sedimentary layers deposited through the action of wind or water thus show a successive series in time, the older layers below and the younger ones above. This does not imply it to be a continuous series. A layer once deposited, may have been exposed to erosion and part of it worn away before the next layer covered it. Such lapses of time are referred to as unconformities and there are at least ten major and many minor ones in these three miles of rocks. Some of them represent lapses of time long

enough for whole mountain ranges to be worn down and planed off by erosion.

The Permian rocks (Kaibab limestone) at the top of the Grand Canyon are covered by the Triassic rocks 3500 feet thick in the region below Zion Canyon. These are covered by the Jurassic rocks 3050 feet thick in the Zion

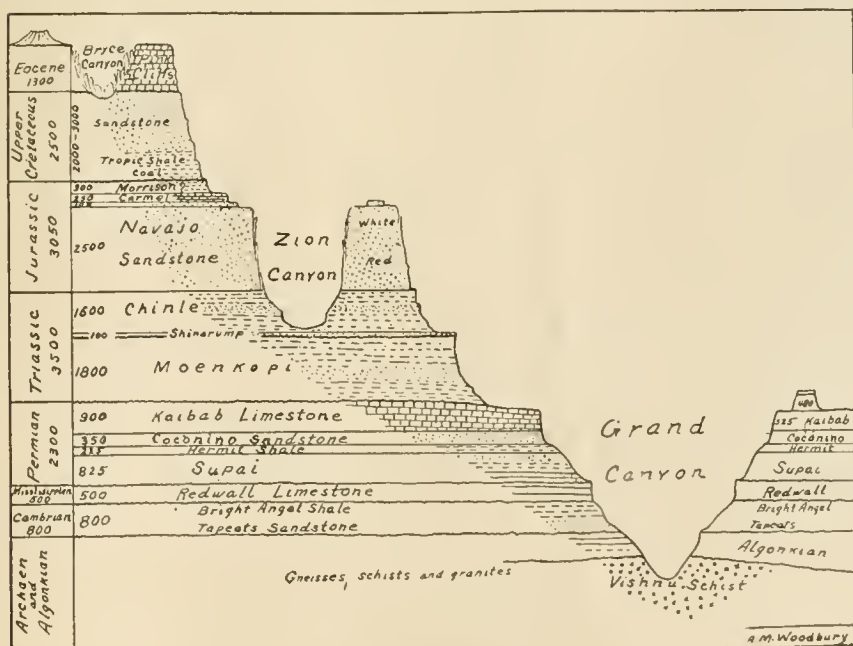


Courtesy United States Department of the Interior
BRYCE CANYON

Compare with Zion Canyon, pictured on our front page

Region. These rocks are in turn buried by those of the Upper Cretaceous, 2000 to 3000 feet thick, which reach up to the bottom of Bryce Canyon. The topmost layer, which is of Eocene age and buries all the others, is a non-marine water-deposited limestone about 1300 feet thick known as the Pink Cliffs. This is the layer in which the indescribably esthetic carvings of Bryce Canyon are cut.

The fossils of algae, primitive as well as higher invertebrates, fishes and the fossil footprints of amphibians found in the Grand Canyon are older and more primitive than fossils found higher up in the series. Fossil remains or footprints are found in the layers of the late Triassic or Jurassic rocks. The writer has taken fossil petrified trees from the early Triassic, ganoid fishes from the later Triassic and has seen many reptile tracks in rocks of the same age. Near Kanab in southern Utah, on top of a projecting ledge where the softer shale from above had worn away, a series of dinosaur tracks were exposed to view. They were as plain and unmistakable as the cow's



DIAGRAMMATIC PROFILE

Columnar Section showing stratigraphic relations of Bryce, Zion and Grand Canyons

footprints which the cowboys follow on the range today. The dinosaurs of a half-billion years ago left their tracks on the muddy bottom lands. The next flood covered them with mud and thus preserved them in the rocks through the long intervening ages. At one point, the tracks of three different animals were found crossing each other—we called it "Dinosaur Junction."

Other fossils have been found in the higher layers, but the record in that region stops at the Eocene in the beginning of Cenozoic (late life) time. Since the Pink Cliff limestone was laid down, the entire region has been uplifted from near sea-level to its present elevation. During the period of uplift, streams of water have been at work wearing away this sedimentary material, cutting washes, gorges and canyons, and leaving the edges of the layers exposed to view. The Colorado River has cut deepest, having reached the bottom of this three-miles of sedimentary material. Even though there is only a mile or more of the material left at the Grand Canyon to show, it is believed that a good deal of the upper material once extended over it and was stripped away before the canyon as we know it now was carved.

Zion Canyon, cut by the Virgin River, a tributary of the Colorado, is three-fourths of a mile deep at its mouth. But this is only a small part of the stream's work.

for it is practically certain that much of the upper mile of rock layers formerly extended over Zion Canyon and was removed by the processes of erosion before the present canyon came into being. Bryce Canyon has been cut about 1300 feet deep through the topmost layer by means of temporary streams produced by storms without the aid of a permanent stream of water.

The time scale revealed by the region, although not complete, indicates a tremendous period for the history of the earth. There are three phases which must be taken into consideration: 1st, time enough for the accumulation of sediments to a depth of three miles (15,000 to 16,000 feet) by the natural processes of sedimentation, involving all of the principal types of deposit, limestone, shale, sandstone, and conglomerate; 2nd, the lost periods of time that elapsed during the unconformities; and 3rd, time enough to carve the present canyons and wear down through the three mile series.

When viewed in the light of recent calculations of earth age by the use of radium, there is little doubt that the history of this southern Utah-northern Arizona region must be read in terms of hundreds of millions, perhaps billions, of years—time enough for the development of the evolutionary changes in living things that biologists recognize to have occurred.

Mammoths and Mastodons

By ALLAN BROMS

EVERYONE knows that mammoths and mastodons are some sorts of elephants, now extinct, and probably thinks them of enormous size, much bigger than living elephants, though this is not true. The name "mammoth" is assumed to have been given because the animal was of mammoth size, but the truth is just the other way round, we call things mammoth after this animal. Actually, the name comes from the Tartar word "mamantu" meaning ground-dweller, for the Siberian peasants found bones and even flesh, but no living animals, and so concluded that these must be giant moles who dug their way underground with their ivory tusks, but promptly died when they accidentally saw the sunlight. So this name was modified and adopted for scientific use. The name "mastodon" means "nipple-toothed", describing its distinctive teeth. Mammoths and mastodons are very different, the mammoth being a true elephant, with elephant teeth, while the mastodon is just a cousin. You can always tell them apart by looking in their mouths. A mastodon tooth looks like a mountain range of serrated peaks, while a mammoth tooth has a flattened surface crossed by narrow ridges of hard enamel which stand out from the softer cement and dentine which wear away faster in use, the surface being thus kept rough for grinding. Besides, a mastodon tooth has several roots, a mammoth tooth but one.

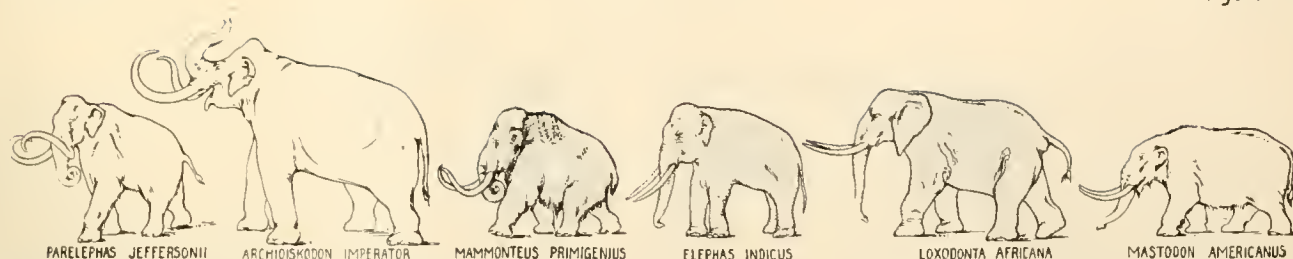
Also, had you seen them in the flesh, you could easily have told them apart. The mammoth was short, tall at the shoulders, low at the hips, his back sloping sharply rearwards. Besides he was narrow when you got a front view. The mastodon was of longer build, not tall either fore or aft, but very wide and broad-backed.

We know just how they looked because we have fine fossil records of them, not only bones, but flesh and hide and hair, and let's not forget, pictures drawn by

primitive man who hunted and was hunted by them. But there are no live mammoths or mastodons, nor have there been for thousands of years. A hundred years ago, it was quite reasonable for President Jefferson, himself a scientist, to look for the finding of live mastodons in the then unexplored Northwest, for the fossil bones looked very fresh, but now that we have explored and not found them, the question is settled, there are no living mammoths or mastodons. But we must discuss them separately, for the mastodon lived last in North America, while the mammoth lived in Asia and Europe too.

The first mastodon bones were found near Albany, N. Y. in 1705. A few years later Cotton Mather wrote that they were the bones of a giant, quoting that "there were giants on the earth in those days". In Europe too, the first remains of mammoths and mastodons were hailed as of giants and of saints, a more reasonable theory being that they were Hannibal's elephants used in invading Rome. The next mastodon finds also came from New York, for in both 1799 and 1802, C. W. Peale found fairly complete skeletons. Soon they came thick and fast, from other states as well, one deposit just south of St. Louis yielding hundreds of individuals. Then in 1845, just fifty miles north of New York City, six miles west of Newburgh, the practically complete Warren skeleton was found with the bones in place just as the mastodon had mired itself in a swamp. It was carefully removed, the parts wired together and then exhibited, first as a travelling show, then in a small Boston museum and now finally, after correct remounting, at the American Museum of Natural History. Miring in swamps and quick sands seems to have been a common death for mastodons. At least that is how most of them are preserved to us.

The mammoth lived here too, but the best fossils are



from Siberia and Alaska, for there they are found frozen into ice that has not melted for thousands of years. In these natural refrigerators they have been kept quite intact, so fresh that dogs eat their flesh. We know that they had a heavy covering of hair and wool fitting them to survive through the long, intense cold of the Ice Age. So we call this species the Woolly Mammoth to distinguish it from others of even larger size that roamed farther south here in North America, namely the Jeffersonian Mammoth and the Imperial Elephant, giant of them all. The mastodon also had a hairy covering, for a golden brown sample has been found. The Woolly Mammoth however stuck closer to the cold edge of the melting ice sheet and northern Siberia is today full of fossil ivory, so full that regular prices are quoted on it in the markets of the world. One of the refrigerated carcasses was found in 1799 in the ice along the Lena River and what remains after the dogs got done with it, is mounted in the museum at Leningrad. Another, found in 1900 at Beresovka, Siberia, was largely saved. It had fallen into a deep pit or crevasse, probably during a blinding blizzard, had broken several bones, and being too crippled to struggle out, had died in the position of climbing. Even the contents of the stomach were preserved, showing that it lived on grasses and birch leaves.

There are many guesses why the mammoth and mastodon, despite their numbers, became extinct. Their intelligence and strength should have saved them. One recent guess (you can guess the source) held that they were too big to get into Noah's Ark and so were drowned. Another is that since elephant skins lack oil glands, moisture could freeze in the hair of the Woolly Mammoth and Mastodon, killing them off. But they survived through the Ice Age and died when the weather became warm. Also, their southern relatives, the Jeffersonian Mammoth and the Imperial Elephant, died out. Maybe some contagious disease wiped out the tribe, we do not really know.

But though we do not know why they disappeared, we do know something about how they began, for fossil remains have been found of their ancestors, mostly in Asia

and Africa. They started in Egypt with the little Moeritherium about two feet tall who lived some tens of millions of years ago in the Eocene Epoch along the River Nile, spending much of his time in it. He had quite an ordinary mouth, without trunk, but with two upper and two lower tusks or long canine teeth. The nearest living relative is the Sea Cow or Manatee. From the very ordinary Moeritherium evolved many strange mastodons and elephants. All had the rooting habit, like our pigs who also develop tusks in their wild state. At first both the lower and upper jaws and tusks grew longer. Then there had to be some way of reaching beyond them for getting food back to where the mouth was. So the nose and upper lip extended into a long flexible tube with a sensitive and very deft tip to feel and handle things with. Slowly through the millions of years this evolution went on, the tusks and jaws and trunk getting longer. In several the lower tusks become spoon-shaped or spade-shaped for digging and scooping. Walter Granger recently showed me one such spade from Mongolia fully a foot wide. A spoon from Nebraska was four feet long. But other species began to lose their long lower jaws and tusks, among them Stegodon, whose teeth are a compromise between those of mammoths and mastodons. Occasionally old mastodon bulls hark back to such four-tusked ancestors by showing tusk remnants in their lower jaws.

With long, heavy upper tusks and trunk, the recent elephants had to have strong, short necks, so the skull changed in shape and bracing to give better leverage. To uphold the ponderous beast itself, the legs became massive pillars, set straight up and down for solidity, supported by compact, tough, padded feet. For centuries the ancients debated whether an elephant had leg joints, he stood so sturdily stiff-legged. With powerful limbs, an overwhelming might, and an ever urging wanderlust, which may be just the curiosity of intelligence, he traveled the world over, invaded new conditions, which made him over to fit them by natural selection, and then generation by generation died to leave the fossil record by which we now decipher his story.

PRESSURE FROM THE PULPIT

Recently a quotation from Hendrik Willem Van Loon's "Story of Mankind," written on a blackboard in Beech Grove school, Indianapolis, sent Rev. Verdi Allen, Baptist preacher, on a rampage with the war cry: "Our people don't want pupils taught the Darwinian theory but the Genesis record."

Principal Mann is reported to have side-stepped him neatly with "Mere citing of the opinion of others does not imply belief in them". While State Superintendent Murray pussyfooted as follows: "The theory of evolution should not be advocated, and frankly I doubt if it is advocated in any school in Indiana." No comment needed.

Help us to offset this pressure from the pulpit by sending EVOLUTION to every public and school library in

Indiana that will accept it. Five hundred dollars will do it. Send a check to help Enlighten Indiana.

SYMPOSIUM ON EARLY MAN

AN INTERNATIONAL SYMPOSIUM on Early Man was held March 17th to 20th under the auspices of the Philadelphia Academy of Science. Many world-renowned anthropologists, archeologists, geologists and anatomists contributed to a summation of present knowledge regarding ancient man. We hope to present some of this interesting material to our readers in an early issue.

Of course, in such a gathering of scientists the *fact* of evolution is taken for granted, and the fundamentalist viewpoint of special creation is no longer considered, or even mentioned. Does this mean anything to our fundamentalist friends and the school boards that they control?

A Lesson In Variation

By RALPH C. BENEDICT

Professor of Botany, Brooklyn College

THIS article outlines a possible laboratory lesson through which the most fundamental factor of evolution may be presented objectively. It has been used a number of years in fourth year high school biology. The facts of morphological resemblances among related forms, geographic distribution, geologic succession of types, embryological and ontogenetic development, plant breeding, etc., are valuable and important as circumstantial evidence, but an understanding of the basic problem of evolution must be sought in a study of *variation* as a *process*.

If occasionally in reproduction parents produce offspring which differ from the parent type, and not merely by the re-shuffling of characteristics already possessed by collateral forms, we are brought face to face with the elemental fact upon which any real understanding of evolution must be based.

Variation is one of the numerous words which have a number of different meanings. The word is not used here in the common interpretation as referring to the range of differences between the individuals of a larger species population. The meaning can be sharply delimited to the desired application by the question: Will evolution take place if offspring always repeat the exact characteristics of their parents? Why must variation occur as a process in reproduction if new forms are to evolve?

Is there any evidence of such variation? The Boston fern series furnish excellent material for class study. They are relatively common, and easy to obtain. The range

of variation between the different varieties is wide, the differences well marked, and the material is large enough so that the difference can be seen easily. The method of reproduction is entirely vegetative, thus eliminating the possibility of complication through hybridization.

The mode by which variation must have taken place in these fern types can be pointed out easily, and is illustrated in figure 1. This shows a parent plant of the wild sword fern from which the Boston fern was derived, in association with three offspring which have arisen along a lateral stolon. Such stolons are common in Boston fern varieties, and the methods of vegetative propagation along stolons can usually be demonstrated by digging up a little surface dirt around a well-established pot plant.

While in general the offspring are practically identical with their parent, a number of times, in the florists'



Courtesy Brooklyn Botanic Garden.

FIGURE 1. Vegetative reproduction of Wild Sword Fern. The three bud plants are all like the parent. In variation one or more would be different.

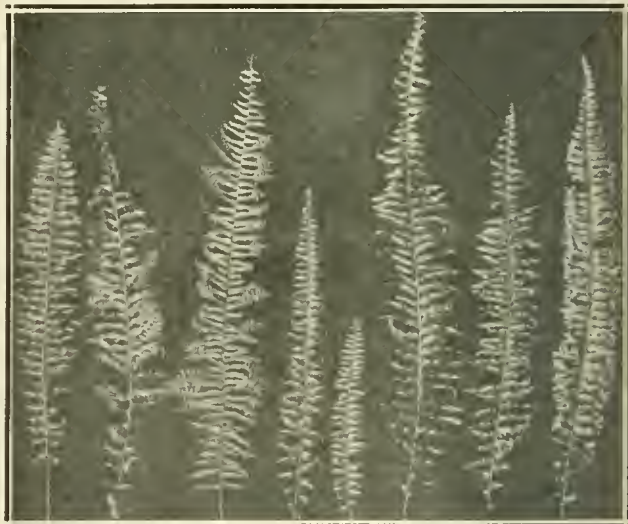


FIGURE 2. Leaf of Boston Fern (left) with leaves of the seven primary sports. In each case, the original mutation took place in vegetative reproduction (see Fig. 1)

cultivation of millions of Boston fern plants, an occasional bud plant has arisen which, while still in physical connection with its parent plant, has shown distinct differences from the parent. Figure 2 shows the leaves of a typical Boston fern together with seven such departures or variations. Beginning with the first plant, each of these variations reproduced only its own type, maintaining the difference from the parent Boston fern, and thus representing that kind of variation which is inherited, or *mutation*.

This does not establish what the process of variation is; it merely makes obvious the fact of its occurrence, and it is evident also, that whatever happened must have taken place somewhere along the stolon or reproductive branch from which the different buds arose.

The third figure, showing representative pinnae of the same leaves shown in figure 2, makes clearer just what types of differences have resulted from the variation process in the Boston fern. These differences parallel to some extent the characteristics which distinguish recognized fern

species. When, in addition, consideration is given to the extreme modifications developed through secondary and further variation in this same group of ferns, resulting in scores and scores of well distinguished varieties, a new understanding should attach to the meaning of variation as a process and its underlying significance in evolution.



FIGURE 3. Pinnae of Boston Fern and seven primary mutations, arranged as in Figure 2.

Dozens of new forms have appeared in the Brooklyn Botanic Garden during the years of experimental culture. Four kinds of variation are represented among these primary sports of the Boston fern (1) increase in division, from once to twice pinnate; (2) dwarfing; (3) increase in ruffling; and (4) cresting.

The second and third leaves represent increased leaf division. The third leaf is from the "Anna Foster" variety, the earliest of all the Boston fern sports. The "Pierson" fern is shown in the second leaf and pinnae. From this form alone, scores of secondary, tertiary and higher degree sports have developed, resulting in various degrees of leaf division—up to five pinnate,—and other modifications.

The fourth and fifth leaves and pinnae represent dwarf types. "Scott's" fern (of Brooklyn origin) and the Giatras fern. In addition to their smaller size, each offers other differences in outline, marginal characters, and configuration of the pinnae, and in the habit of growth.

The sixth and seventh leaves and pinnae present intensification of the ruffling or waving of the pinnae, horticulturally known as *crisping*. The larger leaf (6) is called the "Harris" fern; the other the "Roosevelt". Lastly, there is a *crested* or "fishtail" type of variation, which occurs not infrequently in wild native species. In the Boston fern series this variety first appeared in Louisiana, and takes its name from the town of its origin, "Gretna".

That evolution must have occurred by means of inherited variations will be accepted as axiomatic. The student who has examined material of the kinds presented here will form a clearer conception of what is meant by variation, and a better understanding of the relation of this process to evolution.

From *Torreya* 30: 145-152, Brooklyn Botanic Garden

Evolution Remains Darwinian

By HENSHAW WARD

A recent editorial in the New York *Times* entitled "Darwin Fifty Years After," contained these two sentences: "Research conducted within the last decade has shown that almost imperceptible mutations are the ones that count in evolution, and that by selection their direction and preservation are determined. So we come back to Darwin's own Darwinism." The *Times* is not an authority on biology, but it indicates the trend of recent conservative thought. Its editorial is proof that the greatest hindrance to popular acceptance of Darwinism is disappearing.

That hindrance was the doubt which some biologists felt about Natural Selection. The doubters (mostly students of genetics) were wont to express themselves thus: "Though we have no doubt of evolution, we suspect that Darwin's theory may not be the right explanation." The suspicion was interpreted by many literary and philosophical minds to mean: "Darwinism is in a bad way."

Even if Darwinism had died, the evolution theory would not have been disturbed. But the theory can be much more readily accepted by the general public, and can do its work in education more smoothly, if it does not have to encounter the perpetual query, "But isn't Darwinism disputed?" During the last few years so many authorities have spoken so strongly in support of Darwinism that even the *Times* is persuaded.

The most important element of Darwinism is Natural Selection—the theory that in the hard struggle for existence

Has the Darwinian Theory of Natural Selection been discarded by scientific men as fundamentalists so often profess to believe? Do the latest facts disprove the evolutionary theory? Dr. Ward answers by quoting the opinions of modern scientific authorities.

the favorable variations are preserved in heredity, and that there is thus a gradual alteration in a species which adapts it better for successful living. A less important element of Darwinism, but one that has loomed large and has seemed vital to many reasoners, is the theory that the principal material of evolution has been the small variations. Critics of Darwin have been dubious about the power of Natural Selection, and they have assumed that Darwin's small variations have been supplanted by the large

sporting mutations such as de Vries described.

The following quotations indicate how general and thoroughgoing is the sweep of recent biological thought toward Natural Selection and toward the conviction that no modern investigation of "mutations" has furnished any substitute for Darwin's conception of inheritable variations, whether small or large.

I. Prof. H. J. Muller is the most natural man to quote first:—"Data on the actual occurrence of mutations support Darwin." He knows. His investigations of mutations by X-rays are so highly respected that he was chosen by the *Britannica* to write the article "Variation". In that article he declares: "Geneticists are returning to a view essentially similar to Charles Darwin's—namely, that the origin of one species from another involves the accumulation of numerous selected small steps of heritable variation." Since it was the geneticists who used to raise most doubt about Darwin's conception of variation, there is

special significance in this judgement of a scholar who is in the van of recent genetics.

2. The *Britannica* also secured an entirely new article on evolution, written by Professor Goodrich of Oxford. He argues that "the case against Darwin" has not been established. He speaks of "the process of natural selection whereby adaptation is brought about"—which is a more sweeping claim than Darwin made. He says that no hard-and-fast line can be drawn between "sports" (i.e. large mutations) and small variations. He specifically denies that De Vries distinction between mutations and small variations is valid.

3. The chief concern of H. G. Wells and his advisers when they wrote the *Science of Life* was to expound the views that are considered safest by the specialists. Here is their decision about Natural Selection: "The broad propositions of Darwin reemerge from a scrutiny of the most exacting sort essentially unchanged . . . What has three quarters of a century done to modify Darwin's view? Our answer is 'Practically nothing.'"

4. J. B. S. Haldane is a Cambridge geneticist whose opinion on any subject in his field carries weight. He testifies: "No satisfactory cause of evolution other than the action of natural selection has ever been put forward . . . No facts definitely irreconcilable with Darwinism have been discovered in the sixty years and more that have elapsed since the formulation of Darwin's view . . . Darwin's ideas still hold the field today."

5. Sir J. Arthur Thomson, the veteran maker of a long list of dependable books on biological subjects, is always most careful to present both sides of a case. Yet he is not ambiguous about Natural Selection: "What has happened during the domestication of animals and the cultivation of plants is closely parallel to what has happen-

ed in Wild Nature in the evolution of new species." (*Riddles of Science*). This is a neat summary of Darwin's entire argument, and a complete endorsement of it.

6. In *The Coming and Evolution of Life*, Professor Crampton of Barnard College thus expresses his judgment: "All of the discoveries up to the present time have thus corroborated the essential tenets of Darwin's formula of the dynamics of evolution—i.e. the natural selection of congenital characteristics."

7. Professor L. L. Woodruff in his *Animal Biology*, says of Darwinism: "The consensus of opinion is that natural selection in general is the guiding principle underlying the establishment of the adaptive complexes of organisms . . . So this is essentially a clarified Darwinism . . . Natural selection still affords the only explanation of that co-ordinated adaptation which pervades every form of life."

8. Many an intellectual has expressed his distrust of Darwinism in the *New Republic* during the past decade. Therefore Julian Huxley's verdict in favor of Darwinism had special point when it was published in the *New Republic*: "Whereas at first only large mutations, producing striking effects, were known, intensive study has revealed that small mutations are more numerous, and also more important as raw material for evolution . . . Selection is the main agent which directs and guides that change. . . . Observation and analytic studies of genetics can all be reconciled in the fundamentally Darwinian idea of gradual change, due to the accumulation of small Mendelian mutations under the influence of natural selection."

Julian Huxley's finding is that "We can all be Darwinian again." So we can. There is no longer any need to be troubled by the factional disagreements of the specialists. Evolution remains Darwinian.

Amateur Science

ROBIN THE THRUSH

By PAULINE DEDERER

One sure sign of Spring is the Robin returning from his southern wintering, finding plentiful Spring food in the worms and seeds of man's lawns. His red breast is sufficiently distinctive to identify him to everyone, but is very misleading as to his relationships. He really belongs to the Thrush family and we all know *they* have *spotted* breasts. Nevertheless, the Robin is a Thrush, spots or no spots. He may hide it from himself, but his youngsters give him away. Watch them as they hatch and grow up. Look carefully at their breasts. They do have spots on their breasts, a bit faint perhaps, but still spots, just like any other Thrush. Very probably, the common ancestor of the Robin and his relatives was just a spotted Thrush. The Robin, as it evolved, lost those spots, but its youngsters, by way of summing up the ancestral history in their individual lives, go through that old Thrush stage before assuming the recently acquired red breast. Incidentally, the common Bluebird (not the

Blue Jay, who belongs with the Crows) is also a Thrush, only in his case the secret is fairly safe; his youngsters do not give him away, they have no breast spots. But that absence of spots does not mean a thing, they are still Thrushes, as we know from other resemblances, only they have gotten over their ancestry more thoroughly than the Robin young.

Question Box

FILTERABLE VIRUSES

By LUCY ORENSTEIN

Q. What is meant by a "filterable virus"? I have heard this term used in connection with certain diseases like hydrophobia and measles.—*A Reader*.

A. Filterable Viruses are among the most provoking of organisms because of their elusiveness. They are ultra-microscopic, that is, they cannot be seen even under our most powerful microscopes. They are also filterable, that is, they pass right through our finest filters made of porcelain or special earth. Such filters will trap bacteria and protozoa but cannot catch these viruses. Any knowledge that we have of the filterable viruses is knowledge of their activities in certain dis-

eases, rather than of their structure or appearance.

It is even questioned whether these tiny particles are living organisms, although they are generally accepted as such. All our knowledge concerning them is very recent. The latest investigations suggest the possibility that filterable viruses may be the border-line between the non-living and living worlds.

Not only human diseases are caused by filterable viruses. A disease of tobacco known as leaf mosaic disease has been studied widely by scientists interested in filterable virus. Foot and mouth disease in cattle, psittacosis, the rabbit disease which received so much attention lately because it is communicable to man, are other examples. Among the human diseases believed to be caused by filterable virus are measles, smallpox, influenza, hydrophobia or rabies, and common colds.

The interest in the subject of filterable virus is a two-fold one. There is its relation to disease, which alone would tempt scientists to pursue the subject. There is also the possibility that an understanding of these elusive substances or organisms may bring us closer to an understanding of the very nature of life itself. It may be that the key to life's origin lies right here!

Early Views On Fossils

By F. M. CARPENTER

Department of Paleontology, Harvard University

Fossils have probably been the cause of more curious speculation than any other earthly objects. Fossil shells, crinoids, plants, and even bones are common in most parts of the world and did not escape the notice of the ancient philosophers and writers. The Egyptians apparently had no idea of their nature, although they used petrified logs for the foundations of desert roads. The ancient Greeks,



FOSSIL INSECTS

Ask your fundamentalist friend to explain these fossils

however, correctly recognized them as the remains of once-living organisms. Xenophanes (6th century B.C.) stated that sea shells high up in the hills of Malta indicated that the hills had been periodically submerged under the sea. Other Greek writers, such as Xanthus, Pythagorus, and Herodotus, also accepted this explanation of the origin of the remains of marine shells in inland regions. Theophrastus (300 B.C.), however, believed that fossil bones were produced by a plastic force in the earth. During the early middle ages this view was the accepted one, the correct idea of Xenophanes and his followers being abandoned. This was largely due to the influence of the Christian Church. If anyone who observed sea shells imbedded in rocks forming a mountain range ventured to express his belief that the mountains consisted of materials accumulated under the sea after living creatures appeared on the earth, he was in danger of being punished for heresy; for according to the Holy Writ, land and sea were separated on the 3rd day of creation, but life did not begin until the 5th day. Also, the obvious conclusion from the evidence of fossils that the material forming the rocks must have accumulated over many thousands of years was contrary to the received interpretation of the amount of time which had passed since creation. It is not surprising, therefore, that the favorite mode of avoiding the difficulty was simply to deny that the fossils were remains of living creatures, and to regard them as freaks of nature or "formed stones". Some of the medieval writers supposed that the plastic force producing the fossils came from the stars instead of the earth.

This interpretation of fossils persisted without serious question for about 1,500 years, until Leonardo da Vinci advanced the view that fossils were the remains of animals that once lived on the sea floor. Opposed to this idea two new explanations, conforming to the Christian teachings, were invented. One supposed that the fossils were placed in the earth by the Creator to deceive man; the other claimed that they were the remains of animals killed during the great Deluge of the time of Noah. This latter

idea became very popular and resulted in the formation of the "school of deluvialists". During the 17th century several additional absurd explanations were offered, including that of Martin Lister (1670), who believed that different kinds of rocks produced different types of fossils; and that of Whiston who suggested in his "New Theory of the Earth" that after the fall of man the earth began to rotate, and on November 18, 2349 B.C., it passed through the tail of a comet, which caused the formation and deposition of all fossils!

During the 18th century a series of investigators, notably Liebnitz, Hooke and Guettard, attacked the deluvialists' explanations as well as the other fantastic ones and demonstrated the true biological interpretation of fossils; although of course the dogmatic attitude of the Christian Church was not changed for more than a century later. At the present time individuals can still be found who believe that all fossils were formed in the "flood" or were invented to deceive and mislead mankind.

In view of the influence which the biblical story exerted on the interpretation of fossils, it is not surprising that the medievals tried to associate the fossils with characters mentioned there. At some localities bones or skeletons were found which because of their great size were determined as the remains of some of the giants mentioned in the Old Testament. One of these, found in Austria in 1645, for example, was supposed to be the skeleton of Og (King of Bashan) whose bed is recorded in Deuteronomy as being 18 feet long. All of these bones were shown later (about 1796) by Cuvier to be the remains of mammoths. A tooth displayed by a Roman Catholic Church in Valencia was supposed to have belonged to St. Christopher; and a large bone, regarded as a Saint's arm, was borne through the streets in reverent triumph whenever rain was needed. Both the tooth and the arm were subsequently proven to belong to mammoths. Perhaps the most famous of these cases was the skeleton described by Scheuchzer from Switzerland. He named the specimen



Ancient Life History of the Earth: D. Appleton & Co.

HOMO DELUVII TESTIS

From an old woodcut of the original specimen, still preserved in the Haarlem Museum

"Homo Deluvii Testis", supposing it to be the remains of one of the infamous men who brought about the calamity of the flood. Cuvier later showed that the skeleton was that of a large salamander!

Most civilized people to-day recognize the real nature of a fossil; but that knowledge has been gained only after eighteen centuries of misunderstanding.

BOOKS

IN QUEST OF GORILLAS.—Wm.

K. Gregory and H. C. Raven. Darwin Press, 1937, 241 pages, \$3.50.

Four of the world's great anthropologists are sent by Columbia University and the American Museum of Natural History into the Africa of Du Chaillu, Livingstone and Stanley to observe and photograph, hunt and collect that important, but rare and little known relative of man, the gorilla. They succeeded in bringing back five adult specimens, carefully embalmed for detailed anatomic study, and a live baby, who later grew up in the bosom of Dr. Raven's family of children. Besides the learned Dr. Gregory and his co-author, the experienced explorer, Dr. H. C. Raven, the party included the witty Dr. J. H. McGregor and the athletic Dr. E. T. Engle. Gregory and Engle had additional, secondary errands on this trip, the former to study those "living fossils", the African survivors of the ancient lung-fishes, the latter to take photographs and foot impressions of African natives for study at Columbia.

Ever since Huxley summarized "Man's Place in Nature" three quarters of a century ago, anthropologists have bewailed our lack of detailed knowledge of gorilla anatomy. Such knowledge should throw much light on several problems of man's ancestry. But the two known varieties of this giant ape live in the depths of the Congo jungle and the mountains of Central Africa. Hunting out our poor relation has always been a real man's job. An expensive, well-equipped expedition, months of skillful, patient hunting, a trip across the entire African continent were required. Even with recent facilities for travel the task was formidable. Then there were the problems of careful shooting, so as to make embalming effective, and of transporting these giants, weighing around four hundred pounds, through dense, pathless jungles, down to the coast and across the sea.

But all that is but the technical part of the story, which never mars the racing pages of this absorbing book. For this is travel in a world of wild and magnificent scenery, across the Great Rift Valley and the wonderful Lake Region, up into the mountains, down into the Congo Basin. This world teems with life, plant, animal, human. Every page has its verbal picture of episode, strangeness, interest and fun—protectively colored lizards that disappear when they stop, house-geckos that walk on the ceiling, queer mole-like creatures, kittens with fur

patterns between spots and stripes, ant armies with plodding workers and belligerent soldiers, ostriches that "stalk grandly", giant vipers hunted with a split stick.

Gregory, the dignified Columbia Professor, turns out to be wholly human. He is quite at home with the dancing, laughing, begging natives. He makes friends with the jungle pygmies. Sympathetically he exposes native foibles. There is the native chief, dressed in white duck and sun helmet, who rides a nickel plated bicycle before the crowd, bowing grandly at the admiring applause. And that other native "gentleman" who laid a board floor so he could hear the tramping sound of his white man's shoes. We read of the death-dealing "Leopard Society" executing native justice, of a dainty Juno of queenly poise, of a plaintive Venus of quiet voice, of plaintive melodies which fade into memory's "Lost Chords". Even the calmly efficient Dr. Raven succumbs to the friendly spell of these simple people and confesses to negotiating the sale of a wife (not his own, of course) for two dollars. Most of the tale is told by Gregory, who is finely gifted with vivid description. He goes on gorilla hunts, of course, but largely as observer, Dr. Raven being the official hunter. Both contribute to the stories of the hunt.

By means of booming signal guns word was sent out to all the villages to watch for gorillas, and by drums the reports came in. The pygmies turned out to be good trackers. Again and again the hunters drew close to the elusive giants, heard their stomachs rumble, saw the bushes shaking, caught a glimpse of a hairy arm, more rarely of a peering face. Often some brave male would rush them, but would stop before becoming visible and retreat noiselessly after covering the silent earlier departure of his band. Now and then gorillas have attacked men, maiming or killing with their great strength. However, none of our hunters ran into danger, except Raven perhaps, when he remained behind to finish his hunting after the others had started home, and came down with sleeping sickness, two kinds of malaria, hookworm and ascariasis, all at the same time. But a missionary doctor pulled him through, and every one arrived home safely with a precious cargo of specimens and a tale completely delightful to read.

—Allan Broms

THE SOLAR SYSTEM AND ITS ORIGIN. — Henry Norris Russell. 144 pp.—MacMillan, N. Y. 1935.

Though the first formulation by Swedenborg of the famous Nebular Hypothesis on the origin of the solar system is now fully two centuries old,

the recognition of its fatal flaws dates only from 1900 when Moulton examined mathematically its impossible dynamics. The outstanding difficulty was that the momentum of revolution of the planets and satellites was several times that warranted by their masses relative to that of the Sun.

The immediate result was Chamberlin and Moulton's Planetesimal Hypothesis, the first of the tidal theories (later to be modified by Jeans and Jeffreys) which explain the solar system as torn from the Sun by the gravitational pull of a passing star.

But even at the turn of the century only the most obvious of the facts to be explained had been learned. The planets (including the vast horde of asteroids) all revolved in one direction and nearly all in one plane, as did most of their satellites. That rule applied also to their known rotations and that of the Sun. All this definitely pointed to a common origin.

Now, however, an array of facts has been assembled of which our generation may well be proud. Theory, too, has made notable advances. But the net result of this accumulation of facts, physical, chemical, and mathematical, has so far only added difficulties which no theory of origins has consistently explained. The very presence of planetary atmospheres, the existence of the satellites and particularly of comets, offer special difficulties.

Recent theories have tried to include all this detail of obstinate facts, but with dubious successes. Jeffreys substituted a stellar collision for mere tidal disruption. Nolke borrowed the planets and comets from a nebula through which the Sun may have passed. More recently, Lyttleton, following a suggestion by Russell, assumed the original Sun a binary star, disrupted by a third passing star to form our solar system. Other theories, apparently of little promise, have yet to be worked out in theoretical detail.

Two thirds of this book is devoted to the facts which must be explained and, despite its technical thoroughness, it is unusual for its clearness. The last third covers the theories of origin with the same lucidity. There is none of the usual assumption of scientific certainty, no effort to make evolutionary drama out of the puzzling array of facts. Yet the fundamental fact, that some two billion years ago the Great Event of Planetary Birth took place,—that fact is amply and convincingly demonstrated by independent, yet singularly consistent, evidences. Altogether, as a summary of our present knowledge of our solar system and as a critical evaluation of all theories of its origin, this small volume is quite unsurpassed.

—Allan Broms

Fundamentalist Follies

FROM COLD TO WARM BLOOD

By E. T. BREWSTER

Taylor University at Upland, Indiana, is the sort of institution that picks its teachers for the "soundness" of their beliefs. If, in addition, they turn out to be competent scholars, that is so much to the good.

The Doctor of Philosophy who heads the Department of Biology is, naturally, no Evolutionist. Yet, as he remarks (*Christian Faith and Life*, February, 1932) "... a student, in order to be able to hold any theory, must know all theories," and there is no use, in these days, trying to suppress information. "Doubtless the theory of evolution should be presented; nor will this be dangerous, since its arguments are so easily met. No one has yet found a single evidence (*sic*) of any form of animal life abridging the gulf between the cold-blooded animals and the warm-blooded ones."

Oddly enough, it happens that in the *Scientific Monthly* for May, 1932 (pp. 421-428) appears a summary of seventeen years of work by Dr. Francis G. Benedict, Director of the Nutrition Laboratory of the Carnegie Institution of Washington dealing with this very point. Dr. Benedict stands among the dozen leading men of the world in his field, and his long investigation has employed every device of method and apparatus. Even the familiar thermometer has been replaced by an elaborate electrical tool; while the number of separate determinations approaches a thousand.

"In this gap between cold-blooded and warm-blooded animals," the article concludes "three striking intermediary steps have been noted"—instead of none as set forth at Taylor.

First, there is an African python, studied in great detail. It is, of course, cold-blooded. That is to say, under ordinary conditions, lying quiet, its body temperature is slightly lower than the air around it, because, like other living things, it is all the time evaporating water. But an active snake at once elevates its temperature sometimes as much as ten degrees above its environment.

This particular serpent is a lady—one should perhaps call her a pythoness—and most fortunately she laid some twenty eggs and incubated them. She ought, according to Indiana physiology, to have incubated in vain, not warming her offspring. As a matter of fact, lying quiet, with the air around her at 86, she herself registered 93, as against 98.6 for a "warm-blooded" creature discharging similar maternal duties.

So an incubating pythoness does bridge the gulf. Moreover, this fact, though never before so carefully tested, has been known for at least a couple of human generations.

Then there are the tortoises. These "have a much higher heat production ... than do the snakes, alligators and lizards ... and hence may be considered to occupy an intermediate stage between these animals and the warm-blooded."

Finally, "the hibernating animals likewise represent an intermediate stage ... Indeed, the body temperature of a hibernating warm-blooded animal may easily be the same as that of the snake, alligator, or fish, for its temperature will fall with that of the environment nearly down to the freezing point of water without resulting in the death of the animal."

Besides these "forms of animal life abridging the gulf between the cold-blooded animals and the warm-blooded ones," there is the notorious "duck-bill platypus," which Dr. Benedict has not yet studied for heat-production and body temperature, though the general facts concerning it have likewise been known many years.

This strange creature, in addition to laying eggs like some reptiles and incubating them like others, has all sorts of reptilian features of an anatomical sort. In fact, with its eggs and its primitive milk apparatus and its beak in place of teeth and its distinctly reptilian bones, it is precisely the "missing link" which the Evolutionist needs to connect the hair-covered mammals with their scaly ancestors. The important point for us here is that "the duck-bill" though a true mammal and warm-blooded, keeps its blood considerably cooler than less reptilian members of the class.

Even we men, who carry our heat-regulating devices about as far as any creature ever does, by no means always maintain a perfectly constant blood heat. A human being in a fever may run a temperature of 105 or 106 and live to tell the tale. Or he may cool his blood down to 94 or 95 and recover. So even we are just the least bit "cold-blooded," and in our small way another of those non-existent bridges to lower things.

Once more, then, as so many times before, a Fundamentalist theorizer encounters the Prophet Balaam's old trouble with his ass. The dumb critics will speak—and they always say the wrong thing for Balaam.

Boners From Exams

Leuwenhoek is the father of bacteria.

The earthworm has a long elementary canal.

The Rialto is the business part of Venus.

Funnymentials

"Animals, which move, have limbs and muscles; the earth has no limbs or muscles, therefore it does not move. It is angels who make Saturn, Jupiter, the sun, etc., turn round. If the earth revolves, it must also have an angel in the centre to set it in motion; but only devils live there; it would therefore be a devil who would impart motion to the earth."

The planets, the sun, the fixed stars, all belong to one species—namely, that of the stars. It seems, therefore, to be a grievous wrong to place the earth, which is a sink of impurity, among these heavenly bodies which are pure and divine things.—Seipio Chiaramonti, quoted in "The Great Astronomers," p. 103.

"It is generally held among scientific men that it is the action of the sun upon the earth that causes the latter to revolve upon its axis."—J. C. Derfelt in *Fax* "Official Organ of the American Science Foundation," March, 1932, p. 6.

"Then we have Mendol (*sic*) who experimented with flowers and discovered a rule and thought it would apply to human beings but it did not."

Prof. C. H. Briggs, B. E, *idem*, p. 9.

"The order that is called Phizapod (*sic*) ... have no cilia, but move about by a queer method called ectoplasm ..."
—*Christian Faith and Life*, May, 1932.

"Darwin with all the fuss and feathers and bluster and insane ballyhoo that he could muster, after admitting the mutation of species to be profound ignorance, has employed every art of lying, dishonesty, superstition, flagrant imagination, misrepresentation, fool guessing, and ignorant suppositions in order to junk the blood of human beings with the blood of every beast of the field, every reptile of the marsh and vermin of the sewer, all the way from monkeys back to the larval ooze of primal seas.

"Any thinking man, who knows what evolution is, would rather be known as a horse thief, a pirate or a cowardly bushwhacker, than to be known as an evolutionist ... Evolution is a pack of damnable lies as black as the soot on the walls of hell; too filthy for carrion, too shameful for dens, too foul for the sewer and too prostitute for Jezebel or Semiramis." —Rev. R. L. Stephens, Anti-atheistic Tract Depot, San Antonio, Texas.

Asexual reproduction is that kind in which no pleasure or benefit is derived by either party.

A compound shoreline is one that moves in and out at the same time.

The chief argument against the nebular hypothesis is that it would make the sun revolve around the earth every few minutes.

The axis of the earth is an imaginary line on which the earth takes its daily routine.

The difference between air and water is that air can be made wetter and water can not.

Teachers are invited to report "Boners".



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So many of *EVOLUTION*'S subscribers are teachers and students who travel during the summer that we've decided to publish only during the ten school months, skipping July and August. All old subscriptions at the \$2 rate will be extended the two extra months.

We're mailing this issue in envelopes under postage so *EVOLUTION*'s resumption will not be overlooked. The next issue (Sept.) will go under second class entry.

E. J. Boness

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